

CLAIMS

What is claimed is:

- 1 1. An active optical filter comprising:
2 a filter input component disposed to receive an optical input signal;
3 a filter output component disposed to provide a filtered output signal;
4 an optical amplifier;
5 at least one optical delay element;
6 a surface grating coupler positioned between said optical amplifier and each of said
7 delay elements to form a first light transmission path, said first light transmission path having
8 an end coupled to said filter input component and another end coupled to said filter output
9 component; and
10 a second light transmission path disposed to transmit optical signals without delay
11 from said filter input component to said filter output component.
- 1 2. The optical filter of Claim 1, wherein:
2 said first light transmission path has an input end coupled to said filter output
3 component, and an output end coupled to said filter input component, to produce a filtered
4 output signal comprising an infinite pulse response (IIR) when an optical pulse is applied as
5 an input signal to said filter input component.
- 1 3. The optical filter of Claim 2, wherein:
2 said first light transmission path includes a first surface grating coupler and a first
3 delay element positioned between the input side of said optical amplifier and said filter
4 output component, and a second surface grating coupler and a second delay element
5 positioned between the output side of said optical amplifier and said filter input component.

1 4. The optical filter of Claim 3, wherein:

2 said first light transmission path comprises multiple optical amplifiers, each having
3 associated delay elements and surface grating couplers interconnected to form a filter of
4 selected higher order.

1 5. The optical filter of Claim 1, wherein:

2 said first light transmission path has an input end coupled to said filter input
3 component, and an output end coupled to said filter output component, to produce a filtered
4 output signal comprising a finite impulse response (FIR) when an optical pulse is applied as
5 an input signal to said filter input component.

1 6. The optical filter of Claim 5, wherein:

2 said first light transmission path includes a first surface grating coupler and a first
3 delay element positioned between the input side of said optical amplifier and said filter input
4 component, and a second surface grating coupler and a second delay element positioned
5 between the output side of said optical amplifier and said filter output component.

1 7. The optical filter of Claim 6, wherein:

2 said first light transmission path comprises multiple optical amplifiers, each having
3 associated delay elements and surface grating couplers interconnected to form a filter of
4 selected higher order.

1 8. The optical filter of Claim 1, wherein:

2 each of said surface grating couplers comprises a grating surface emitter photonic
3 integrated circuit.

1 9. The optical filter of Claim 1, wherein:

2 each of said surface grating couplers comprises a photonic crystal.

1 10. The optical filter of Claim 1, wherein:
2 each said surface grating couplers comprises a trench coupler.

1 11. The optical filter of Claim 1, wherein:
2 Said filter is turnable to transmit only optical signals of a specified frequency.

1 12. The optical filter of Claim 1, wherein:
2 said filter is programmable to transmit only optical signals lying in a passband of
3 specified bandwidth.

1 13. An active optical lattice filter for selectively processing an optical input
2 signal, said lattice filter comprising:
3 a plurality of optical gain blocks spaced apart from one another in a linear array;
4 a surface grating coupler positioned between each pair of adjacent gain blocks in said
5 array, each of said surface grating couplers disposed to transmit a portion of an optical signal
6 received as an input from one of its adjacent gain blocks to its other adjacent gain block, and
7 to reflect the remainder of said received input; and
8 each of the gain blocks is provided with controllable gain and delay characteristics
9 respectively selected to produce an output from said array comprising an IIR when said input
10 signal comprises an optical pulse.

1 14. The active lattice filter of Claim 13, wherein:
2 said gain blocks are respectively implemented by placing electrodes in spaced apart
3 relationship upon an active region of semiconductor material to form corresponding gain
4 regions therein; and
5 each of said surface grating couplers comprises a grating formed in the surface of said
6 active region between adjacent gain regions.

1 15. A 2-Dimensional lattice filter disposed to selectively process an input signal,
2 said lattice filter comprising:

3 a plurality of delay blocks, each delay block disposed to receive, process and project
4 specified signals, said delay blocks grouped into at least one filter section for said lattice
5 filter; and

6 a plurality of 4 direction couplers, each 4 direction coupler being associated with
7 delay blocks in at least one of said filter sections, each 4 direction coupler positioned to
8 exchange specified signals directed along a first axis with one of its associated delay blocks,
9 and to exchange specified signals directed along a second axis orthogonal to said first axis
10 with another of its associated delay blocks.

1 16. The 2-Dimensional lattice filter of Claim 15, wherein:

2 said input signal comprises an optical signal pulse.

1 17. The 2-Dimensional lattice filter of Claim 16, wherein:

2 each of said 4 direction couplers has two pairs of faces, the faces of each pair being
3 parallel to one of said first and second axes.

1 18. The 2-Dimensional lattice filter of Claim 16, wherein:

2 at least one of said delay blocks has a controllable gain for selectively amplifying a
3 signal coupled therethrough.

1 19. The 2-Dimensional lattice filters fo Claim 18, wherein:

2 said filter is disposed to operate as an active filter.

1 20. The 2-Dimensional lattice filter of Claim 19, wherein:

2 each of said 2D lattice couplers comprises a crossed grating coupler.

1 21. The 2-Dimensional lattice filter of Claim 19, wherein:
2 each of said direction couplers comprises a crossed beam splitter.

1 22. A 2-dimensional filter section comprising:
2 a plurality of delay blocks positioned around a closed loop in spaced apart
3 relationship; and
4 a plurality of 4 direction couplers interspersed between said delay blocks to form a
5 closed path for signal flow, each of said 4 direction couplers disposed to exchange specified
6 signals with two adjacent delay blocks along first and second orthogonal axes, respectively.

1 23. The 2-Dimensional filter section of Claim 22, wherein:
2 said filter section is disposed to receive an input signal comprising an optical signal
3 pulse.

1 24. The 2-Dimensional filter section of Claim 23, wherein:
2 at least one of said delay blocks has a controllable gain for selectively amplifying a
3 signal coupled therethrough.

1 25. The 2-Dimensional filter section of Claim 24, wherein:
2 said filter section is disposed to operate as an active filter.

1 26. The 2-Dimensional filter section of Claim 25, wherein:
2 each of said 4 direction couplers comprises a crossed grating coupler.

1 27. The 2-Dimensional filter section of Claim 25, wherein:
2 each of said 4 direction couplers comprises a crossed beam splitter.

1 28. The 2-Dimensional filter section of Claim 22 wherein:
2 said filter section comprises a particular filter section of a higher order 2-Dimensional lattice
3 filter comprising multiple filter sections, each substantially identical to said particular filter
4 section.

1 29. A 2-Dimensional filter stage comprising:
2 a linear array of 4 direction couplers positioned in spaced apart relationship along a
3 first axis, each of said 4 direction couplers disposed to establish selected transmission paths
4 for signals traveling along said first axis, and to establish other transmission paths for signals
5 traveling along other axes that are respectively orthogonal to said first axis;
6 one or more first delay blocks, each positioned between two of said 4 direction
7 couplers to selectively process signals traveling therebetween along said first axis; and
8 a plurality of second delay blocks, each positioned along one of said orthogonal axes
9 to selectively process signals directed therealong by a corresponding one of said 4 direction
10 couplers.

1 30. The 2-Dimensional filter stage of Claim 29, wherein:
2 said filter stage is disposed to receive an input signal comprising an optical signal
3 pulse.

1 31. The 2-Dimensional filter stage of Claim 30, wherein:
2 at least one of said delay blocks has a controllable gain for selectively amplifying a
3 signal coupled therethrough.

1 32. The 2-Dimensional filter stage of Claim 31, wherein:
2 said filter stage is disposed to operate as an active filter stage.

1 33. The 2-Dimensional filter stage of Claim 32, wherein:
2 each of said 4 direction couplers comprises a crossed grating coupler.

1 34. The 2-Dimensional filter stage of Claim 32, wherein:
2 each of said direction couplers comprises a crossed beam splitter.

1 35. The 2-Dimensional filter stage of Claim 29 wherein:
2 said filter stage comprises a particular filter stage of a higher order 2-Dimensional
3 lattice filter comprising multiple filter stages, each substantially identical to said particular
4 filter stage.

1 36. A 2-Dimensional filter stage comprising:
2 a linear array of multi-direction couplers positioned in spaced apart relationship along
3 a first axis, each of said multi-direction couplers disposed to establish selected transmission
4 paths for signals traveling along said first axis, and to establish other transmission paths for
5 signals traveling along other axes with respect to said first axis;
6 one or more first delay blocks, each positioned between two of said multi-direction
7 couplers to selectively process signals traveling therebetween along said first axis; and
8 a plurality of second delay blocks, each positioned along one of said other axes to
9 selectively process signals directed therealong by a corresponding one of said multi-
10 direction couplers.